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ABSTRACT

Gender differences have been reported in the United States in the areas of mathematical reasoning favoring males and verbal abilities favoring females. Results from the National Assessment of Educational Progress Science Assessment also have consistently revealed small gender differences favoring males. This paper reports gender differences in Costa Rican elementary and secondary schools and discusses some of the possible mechanisms related to the development of these differences in the Costa Rican context, especially those pertaining to the scientific area. Gender differences are reported for mathematics, science, and Spanish. The grade levels were 4th, 6th, 7th, 10th, and 11th. The data for this analysis were collected as part of larger studies on evaluation of the teaching of the subject matters executed by the Research Institute for the Improvement of Costa Rican Education from 1982 to 1986. Results indicated that at the fourth grade level, there were no significant differences in any subject matter. The boys had significantly better achievement in science and mathematics than did the girls for 6th, 7th, 10th, and 11th grade levels. On the other hand, the girls surpassed the boys in the same grade levels in Spanish, except for 10th grade where no significant sex differences were found. (CW)

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# GENDER DIFFERENCES IN ACHIEVEMENT IN COSTA RICAN STUDENTS: SCIENCE, MATHEMATICS AND SPANISH

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## INTRODUCTION

This paper reports gender differences in achievement in Spanish, Science and Mathematics of Costa Rican elementary and secondary students. It also discusses some of the possible mechanisms related to these differences in the Costa Rican context, specially those pertaining to the scientific area. For country like Costa Rica, that is trying to develop its own scientific and technological base, in order to have a steady economical development that would enable it to become one of the first developed countries in Latin America, it is very important that technological and scientific careers be followed by boys and girls as well, so that good human resources can be available for the growth of the country. Science and Mathematics education have to play a paramount role in order to motivate talented girls and boys to enter technological and scientific related careers. According to this reasoning, it would be interesting to find out what differences, if any, are there between boys and girls in Science, Math and Language (Spanish) achievement, how to explain the differences, and what changes have to be made in order to diminish the differences. This study pretends to answer the first of the questions asked before.

Gender differences have been reported in the United States in the areas of mathematical reasoning favoring males and berval abilities favoring females (Macoby and Jacklin, 1974). Steinkamp and Maehr (1984) also reports in a meta - analysis of 406 studies that small sex differences do exist between boys and girls in Science achievement. Several others reports showed higher mathematical reasoning abilities for males than females (Benbow and Stanley, 1980; Rosenthal and Rubin, 1982). One relevant questions that is raised by Becker and Jacobs (1983) and Hogrebe (1987) is related to the statistical significant but small differences that are generally report and what the educational significance of these differences is. Results from the National Assessment of Educational

Progress Science Assessment have consistently revealed small gender differences favoring males. (Linn et al, 1987).

Gender differences are reported for Mathematics, Science and Spanish for students on fourth, sixth, seventh, tenth, and eleventh grades. The data for this analysis was collected as part of larger studies on the evaluation of teaching of these subject matters executed by IIMEC (Research Institute for the Improvement of Costa Rican Education) from 1982 to 1986.

Methodology

The samples in each subject matter were composed by the students enrolled in $7^{th}$, $10^{th}$ and $11^{th}$ grade levels, in a random sample of 20% of the high school in the country. The samples of $4^{th}$ and $6^{th}$ grades were also drawed at ramdon, from 20% of the elementary schools pertaining to the school districts of the high school already selected as explained before.

The sample of student answering the tests comprised a total of 13860. The composition of the sample can be appreciated in Table #1.

TABLE #1. NUMBER OF STUDENTS ANSWERING THE TESTS BY GRADE LEVEL AND SUBJECT MATTER

| GRADE | MATH | SPANISH | SCIENCE | TOTAL |
|---|---|---|---|---|
| 4 | 1243 | 744 | 1011 | 2998 |
| 6 | 1335 | 1042 | 1029 | 3406 |
| 7 | 1515 | 782 | 793 | 1090 |
| 10 | 960 | 714 | 448 | 2122 |
| 11 | 950 | 755 | 539 | 2244 |
| TOTAL | 6003 | 4037 | 3920 | 13860 |

The following problems were established in this study:

1- Is there a difference in achievement between boys and girls in Mathematics in 4 $^{th}$, 6 $^{th}$, 7 $^{th}$, 10 $^{th}$ and 11$^{th}$ grades?

2- Is there a difference in achievement between boys and girls in Science in 4$^{th}$, 6$^{th}$, 7$^{th}$, 10$^{th}$ and 11$^{th}$ grades?

3- Is there a difference in achievement between boys and girls in Spanish in 4$^{th}$, 6$^{th}$, 7$^{th}$, 10$^{th}$ and 11$^{th}$ grades?

4- Is there a difference in the trend established for Mathematics and Science, and that established for Spanish?

The test for Science and Mathematics were criterion-referenced tests constructed and validated as it is explained by Esquivel, Delgado, and Peralta (1983) and Esquivel and Quesada (1984). These C-R tests have different lengths depending on subject matter and grade level, but in all of them, three items were measuring each objetive. All items in the tests were multiple choice items. For the purpose of this report, the total right answers were used as the score of each test.

The Spanish tests were norm - referenced tests comprised of different classes of items measuring grammar, reading comprehension, spelling, and composition. These tests were constructed and validated by Rojas, García, and Fajardo (1985) and have good evidence of content validity and acceptable reliability indexes. A composed total score in each test is used for the analysis presented here.

Results

Means and standard deviations for each subject matter and grade level can be appreciated in talbe #2.

TABLE #2. MEANS AND STANDARD DEVIATIONS OF THE TESTS BY GENDER FOR MATH, SPANISH, AND SCIENCE

| GRADE | | MATH | | SPANISH | | SCIENCE | |
|---|---|---|---|---|---|---|---|
| | | FEMALE | MALE | FEMALE | MALE | FEMALE | MALE |
| 4 | $\bar{X}$ | 35.79 | 36.59 | 101.91 | 98,23 | 27.38 | 28.25 |
| | S | 11.89 | 11.55 | 23.50 | 27.07 | 6.62 | 7.61 |
| 6 | $\bar{X}$ | 29.10 | 30.21 | 89.21 | 84.78 | 20.33 | 22.04 |
| | S | 9.59 | 10.14 | 20.59 | 21.73 | 5.19 | 5.57 |
| 7 | $\bar{X}$ | 33.31 | 35.23 | 156.65 | 148.33 | 30.22 | 32.87 |
| | S | 9.27 | 9.95 | 29.15 | 26.56 | 8.67 | 9.28 |
| 10 | $\bar{X}$ | 28.49 | 33.26 | 103.98 | 102.19 | 21.33 | 22.99 |
| | S | 11.35 | 12.33 | 24.35 | 22.43 | 5.28 | 9.28 |
| 11 | $\bar{X}$ | 25.82 | 30.62 | 108.79 | 99.06 | 6.39 | 7.13 |
| | S | 12.35 | 13.98 | 21.07 | 22.88 | 2.37 | 2.53 |

In Mathematics the differences increase as the grade level is higher, it is less than a point in fourth grade but in eleventh it reaches almost five points: all the differences favor males. In Science the differences follows the same pattern, but they are smaller than in Mathematics. Spanish presents differences favoring females that increase from fourth to eleventh grade, with the exception of tenth grade where it is very small.

A series of ANOVA'S were conducted in order to study the differences observed before, by grade level and subject matter.

TABLE #3. F VALUES AND PROBABILITIES AS A RESULT OF THE ANOVAS

| GRADE | MATH | | SPANISH | | SCIENCE | |
|---|---|---|---|---|---|---|
| | F | PROB | F | PROB | F | PROB |
| 4 | 1.472 | 0.2253 | 2.232 | 0.1359 | 3.727 | 0.0538 |
| 6 | 4.219 | 0.0402 | 6.458 | 0.0113 | 28.474 | 0.0000 |
| 7 | 15.044 | 0.0000 | 17.290 | 0.0000 | 17.252 | 0.0000 |
| 10 | 38.853 | 0.0000 | 1.188 | 0.2760 | 9.078 | 0.0027 |
| 11 | 31.650 | 0.0000 | 36.634 | 0.0000 | 12.338 | 0.0005 |

Table #3 shows the F values and probabilities for each of the differences tested. At the fourth grade level there are no significant differences in any subject matter. The boys have significant better achievement in Science and Math than the girls for $6^{th}$, $7^{th}$, $10^{th}$ and $11^{th}$ grade levels. On the other hand, the girls surpass the boys in the same grade levels in Spanish, except for $10^{th}$ grade where no significant differences are found.

Discussion

The identification of gender related differences in achievement in Mathematics, is consistent with the findings reported in the United States and in a cross - cultural study which included 12 countries (Steinkamp, Harnisch, Walberg, and Tsai, 1985). Results for the verbal skills area (Spanish) are also consistent with previous research. The lack of gender differences at the $10^{th}$ grade level is unexpected in view of the pattern of results in this area, and requires further exploration.

Results for the Science assessment also reproduced findings in the United States. With respect to the possible mechanism related to the development of these differences, researchers in the Science achievement area have suggested several hipotheses which include: consideration of differences in prior instruction, in response to uncertainty, on item presentation, and on attitudes toward Science (Linn et al, 1987).

With respect to the impact of prior instruction, the curriculum for Science education in Costa Rica does not allow for differences in course taking, i.e., all students are required to take the same courses in Science up to the grade levels included in this assessment.

Previous research in the area of attitudes toward Science, indicated that no gender related differences among students were found on this respect (Esquivel and Krajkovich, 1984).

The consideration of a differential response to uncertainty and to figurally presented items has not been studied at present; Costa Rican National assessment tests do not include the "I do not know" response, and no studies have yet addressed the impact of item presentation. As a result of this study, the "I do not Know" response will be included in the 1988 National Assessment in all three areas and the item presentation impact will be considered in future research at I.I.M.E.C.

These findings elicit a number of relevant questions, particularly those related to the nature and significance of the differences found. As it was mentioned in the introduction, the discussion of the nature of gender differences in achievement is not settled yet, but their impact on women's career choices and professional development is larger than should be expected, if

additional social factors are nor considered. With respect to the nature of these differences, the present study supports the importance of early adolescence as a critical period for the emergence of gender related differences. The impact of biological changes which interact with psychosocial factors to create subtantial differences in the needs and expectations of boys and girls should be carefully studied. The consideration of processes such as stereotyped sex - role identification and social reinforcement contigences seems crucial to understand the development of the differences reported.

The study by Steimkamp and others (1985) pointed out the importance of these factors in each particular culture. Costa Rica in still a rather traditional society with clear sex - role division. Women comprise less than 25% of the labor force and only 10% of the elected people for the National Assembly are females. With respect to availability of models in school, the majority of Math teachers are males, while Spanish teachers are usually females.

The question of the educational significance of these differences should be explored further. A better understanding of the nature of this process would enable both researchers and educators to design and implement appropriate intervention strategies to promote better opportunities for women's participation in the country's efforts for scientific and technological development.

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